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(54) Title of invention:      Hearing aid

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Specification

1. Title of invention

Hearing aid

2. Scope of claims

- (1) A hearing aid consisting of a miniature earphone enclosed in a plastic capsule inserted in the user's ear canal, which is connected by a cord to the main unit of the hearing aid of the behind-the-ear type.
- (2) A hearing aid according to Claim 1 of this invention with the earmold shell fitting inside the ear canal.

### 3. Detailed explanation of the invention

#### Field of applications

This invention relates to hearing aids with the behind-the-ear type main unit.

#### State of the art

Design of a conventional hearing aid with the main unit of the behind-the-ear type is shown in Fig. 3. Below, we explain the design of such a conventional hearing aid with reference to Fig. 3. In Fig. 3, 21 is an eartip made of silicone attached to an eartip holder 22. Eartip holder 22 is connected to a hanger 24 via sound-transmitting tube 23. Item 25 is a miniature earphone connected to the hanger 24 via the earphone outlet tube 34. Acoustic pressure generated by this earphone 25 is transmitted to the user's ear canal through the following path: earphone outlet tube 34 --> hanger 24 --> sound-transmitting tube 23 --> eartip holder 22 --> eartip 21. Item 26 is a microphone, item 27 is a volume control, item 28 is a switch, item 29 is a battery, item 30 is an adjustment trimmer, item 31 is a battery case, item 32 is an amplifier, item 33 is a plastic case, and item 35 is a printed circuit board. In some cases, because of the shape of the user's ear canal, eartip 21 can not be sufficiently inserted in the canal, which results in howling. Therefore it is also possible to use an earmold shell 36 (shown in Fig. 5) fitting the user's ear canal precisely. In addition, in order to suppress peaks in the frequency characteristic, it is also possible to insert an acoustical filter 37 (shown in Fig. 4) in the hanger 24.

#### Problems to be solved by this invention

However, since in the above mentioned behind-the-ear type hearing aids, the earphone 25 is located inside the case 33, the sound output has to travel from the earphone outlet to the user's ear canal via the path

consisting of the earphone outlet tube 34 --> hanger 24 --> sound-transmitting tube 23 --> eartip holder 22 --> eartip 21. This results in distortion in the frequency characteristic of the hearing aids which, as it can be seen from Fig. 6, has from 4 to 5 peaks, starting at a frequency of approximately 1 kHz, and respective dips. As a result of these peaks and dips of frequency characteristic, the sound loses its natural tones and becomes less clear. It is possible to suppress peaks and dips of the frequency characteristics of conventional behind-the-ear type hearing aids by using acoustic filter 37 (which is shown by solid line in Fig. 7), thus improving their frequency characteristics to some degree, however it is difficult to smooth peaks and dips over the entire range of the frequency characteristics.

In addition, due to the fact that the earphone is located inside the main unit, it is necessary to prepare a number of behind-the-ear hearing aids for the users trying to select an earphone most suitable to their hearing ability, which seriously limits the selection options.

The purpose of this invention is to eliminate these disadvantages, by taking the miniature microphone 25 out of the main case 33 and to use it instead of the eartip of the conventional hearing aids. This purpose is achieved by enclosing the earphone in an earmold shell 36 made to fit the user's ear canal precisely and by connecting the earphone by a cable to the amplifier located in the main case of the hearing aid. This makes it possible to eliminate peaks and dips in the frequency characteristics caused by the tube and provides more options to the user in the selection of a hearing aid best suited to his hearing abilities.

#### Methods for solving the problems

In order to achieve the purposes of this invention, the miniature microphone is placed inside the earmold shell precisely fitting the shape of the user's ear, rather than the using of a conventional acoustic conduit in the form of a tube transmitting acoustic pressure from the miniature microphone to the ear canal. In other words, the earphone is placed directly in the external ear canal of the user, thus making it possible to deliver the output acoustic pressure into the external ear canal without distortions. It is also possible to easily select an earphone mounted in the earmold shell which produces the best results from a wider selection of options.

#### Operation

Due to the above mentioned design, this invention has the following effect. Since the miniature earphone is placed in the ear canal, the frequency characteristic of the acoustic output of the hearing aid is relatively flat having only one to two peaks and dips compared to that of the conventional devices.

In addition, since the earphone is removed from the main unit to the outside, it can be placed at a distance from the microphone located inside the case. This makes it possible to substantially reduce the acoustical and vibrational feedback (producing so-called howling effect), thus providing for a more stable performance than conventional units.

It is also possible to make earmold shells with various types of earphones thus facilitating the task of matching the hearing aid acoustic parameters to specific auditory characteristics of hearing impaired users, thus making it unnecessary to prepare several hearing aids for the testing as it is done in conventional units.

Since the miniature earphone is smaller than the external auditory canal of ordinary people, the earmold shell can be made very small so that it entirely fits inside the ear canal and is practically inconspicuous to an outside observer.

#### Embodiments

Fig. 1 represents the first embodiment of this invention.

In Fig. 1, item 1 is a miniature earphone mounted inside the earmold 10 molded according to the shape of the user's ear. Earmold 10 has a vent 11 for the passage of air. Item 2 is a microphone, item 3 is a volume control, item 4 is a switch, item 5 is a battery, item 6 is a battery case, item 8 is an adjustment trimmer, item 17 is an electronic circuitry and item 16 is a printed circuit board. All these components are placed inside the main case 7 of the hearing aid. Electric output signals are delivered to the miniature earphone 1 by the cable 13 connected to the power output terminals located on the printed circuit board 16. The cable 13 runs through the tube 12 of the hanger 9 and it is spliced to a connector 14. In the earmold 10 containing the miniature earphone 1, there is a connector 15 which can be joined with the connector 14. Electric signals from the main unit are transmitted to the miniature earphone through these connectors. The advantage of such a design consist in the fact that it is possible to easily prepare a hearing aid having optimal characteristics by preparing an earmold shell consisting of a miniature earphone 1, an earmold 10 and a connector 15 in which earphone 1 can be easily replaced with a number of earphones of different types.

Fig. 2 depicts essential components of another embodiment of this invention. In this embodiment, the miniature earphone 1 is connected directly to the main unit by cable 13, which is fixed to the earmold 10,

without connectors 14, 15. Therefore, in this embodiment it is impossible to change earphones, however, due to the fact that the earphone is placed inside the auditory canal, the frequency characteristics of the hearing aid are rather flat.

#### Effect of the invention

As it is clear from the explanations given above concerning the embodiments of this invention, by removing the earphone from the main unit of a behind-the-ear type hearing aid and by mounting it in the earmold shell, it is possible to obtain frequency characteristics which are flatter than those of conventional behind-the-ear hearing aids.

In addition, by switching the earmold shell with enclosed miniature earphones of different types, it is possible to adjust the characteristics of the hearing aid to the specific needs of the user.

It is also possible to make the earmold shell sufficiently small so that the hearing aid is only marginally noticeable, thus giving the user psychological comfort and substantially reducing acoustical feedback (howling effect).

#### 4. Simple explanation of the drawings

Fig. 1 represents the design of the hearing aid according to the first embodiment of this invention; Fig. 2 depicts major components of another embodiment of this invention; Fig. 3 shows the design of a conventional hearing aid; Figs. 4 and 5 depict details of a conventional hearing aid; Fig. 6 is frequency characteristic of a conventional hearing aid; Fig. 7 is an improved frequency characteristic of a conventional hearing aid.

- 1 — miniature earphone
- 2 — microphone
- 3 — volume control

- 4 — switch
- 5 — battery
- 6 — battery case
- 7 — main unit
- 8 — adjustment trimmer
- 9 — hanger
- 10 — earmold
- 11 — vent
- 12 — cable sleeve
- 13 — cable
- 14 — connector
- 15 — connector
- 16 — printed circuit board
- 17 — electronic circuitry

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Fig. 1

- 1 — miniature earphone
- 2 — microphone
- 7 — main case
- 9 — hanger
- 10 — earmold
- 13 — cable

Fig.2, Fig. 3, etc.